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(6) # A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE.

(10) Norwood P. Kneppreth, William Hoessel, and David H. Gustafson
~~University of Wisconsin~~

~~and~~

Edgar M. Johnson
Army Research Institute for the Behavioral and Social Science:

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A variety of techniques exist for evaluating and assessing subjective worth. The present Technical Paper develops and presents a strategy for selecting the most appropriate worth assessment technique for a given situation.

A three-round Delphi procedure was used to systematically solicit and collate informed judgments from practitioners and experts in the field of worth assessment. → over

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The first Delphi questionnaire identified 41 factors influencing the selection and successful use of worth assessment techniques.

The second Delphi questionnaire was used to determine the relative importance of the 41 factors identified in the first round of the Delphi. Ten composite factors, four dichotomous and six continuous, were developed which appeared to account for the 41 factors and their relative weights.

The third Delphi questionnaire was used to develop a profile for ~~nine~~ 9 different worth assessment techniques on the six continuous factors. A ~~three~~-step strategy, based on the 10 composite factors, was developed for selecting a specific worth assessment technique for a given situation.

The strategy developed for selecting a worth assessment technique should serve to increase the successful application of worth assessment techniques to specific situations, such as occur in the appraisal of intelligence information.

Technical Paper 280

A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

Norwood P. Kneppreth, William Hoessel, and David H. Gustafson
University of Wisconsin

and

Edgar M. Johnson
Army Research Institute for the Behavioral and Social Sciences

Robert S. Andrews, Supervisory Project Director

BATTLEFIELD INFORMATION SYSTEMS TECHNICAL AREA
Robert S. Andrews, Chief

Submitted by:
Joseph Zeidner, Director
ORGANIZATIONS & SYSTEMS
RESEARCH LABORATORY

Approved By:
J. E. Uhlaner
TECHNICAL DIRECTOR

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

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Intelligence Systems

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FOREWORD

The Battlefield Information Systems Technical Area of the U. S. Army Research Institute for the Behavioral and Social Sciences (ARI) is concerned, in part, with human information analysis, interpretation functions, and subsequent utilization of the products in intelligence systems.

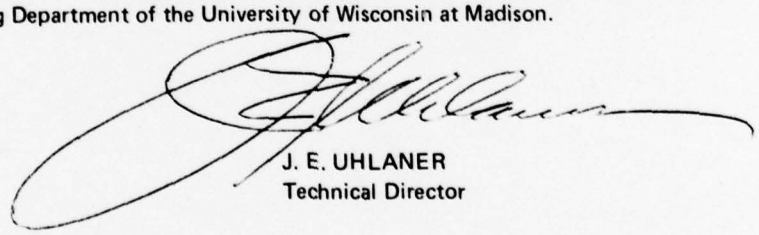
The objective is to provide technological advances in human/machine- aided tactical intelligence information processing and the translation of these advances in support of intelligence systems requirement and design decisions, and formulation of doctrine and procedures.

Achievement of the required technology is often inhibited by a lack of understanding of fundamental principles. Where this is true, the requirement is to increase the scientific basis underlying the state of the art.

One such area is the assessment of subjective value or worth, which has been addressed in ARI Technical Paper 254, "Techniques for the Assessment of Worth." A functional assessment technology is needed to support efforts such as determination of the value of intelligence data and improvement of intelligence collection procedures.

The present publication presents a strategy for selecting the most appropriate worth assessment technique for a given situation. The research effort is responsive to requirements of RDTE Project 2006210IA754. "Intelligence Information Processing," and to special requirements of the U. S. Army Intelligence Center and School.

ARI research in this area is conducted as an in-house research effort augmented by contracts with organizations selected as having unique capabilities and facilities for research in a specific area. The present study was conducted jointly by personnel of the Army Research Institute and the Industrial Engineering Department of the University of Wisconsin at Madison.



J. E. UHLANER
Technical Director

A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

BRIEF

Requirement

To determine the factors influencing the outcome of worth assessment and to develop a strategy for selecting the most appropriate worth assessment technique for a specific decisionmaking problem.

Procedure

A large number of techniques of worth assessment - a term applied to the analysis of subjective value judgments and their reduction to a quantitative scale - have been developed. In the present analysis, a strategy was developed for selecting a worth assessment technique for specific application based on a 3-round Delphi procedure.

In the first round, 41 factors influencing the selection and successful use of worth assessment techniques were identified by a questionnaire distributed to analysts active in the worth assessment field.

The second Delphi questionnaire was used to determine the perceived relative importance of the factors. Ten composite factors, four dichotomous and six continuous, appeared to account for the 41 factors and their relative weights.

Reference profiles for nine techniques were developed for the six continuous factors, based on a third Delphi questionnaire.

Findings

The research product is a three-step strategy for selecting a worth assessment technique for a given situation, based on the ten composite factors.

The first step is the analysis of the four dichotomous factors to screen out techniques not suited to the situation. The second step is an evaluation of the situational requirements (attributes) for a technique, based on the six continuous factors.

Finally, the situation profile is compared with the reference profiles to determine which of the nine techniques is most appropriate for the given situation.

Utilization of Findings

Worth assessment is a vital ingredient of advanced intelligence information processing. The strategy developed cannot be said to insure selection of the perfect technique. However, such strategy should serve to increase likelihood of success in worth assessment application by leading the user to consider situational factors and attributes of available worth assessment techniques.

A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

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A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

Subjective worth forms the basis for the selection of future alternatives and the evaluation of past actions. Techniques for measuring subjective worth extend back to the eighteenth century.*

In the last 30 years, there has been an explosive growth in the research on the theory of subjective worth and a proliferation of assessment or scaling techniques in this field. This Technical Paper addresses two related questions.

First, what specific factors are likely to affect the success of a worth assessment technique? Second, what strategy can be used to select an appropriate worth assessment technique for a specific application?

There are factors which not only differentiate one worth assessment technique from another, but also determine the relative success of techniques in a specific application. An extensive literature search yielded little information on why a particular technique was used in a given situation or how the technique was chosen.**

The idea that one technique would be more appropriate in a given situation while another would be better in a different situation has not been extensively considered.

METHOD

Given the paucity of information in the literature, the remaining source of information was the collective knowledge of the practitioners and experts in the field of worth assessment, gathered by a Delphi procedure. The Delphi procedure involves the sequential individual questioning (usually by questionnaire) of a set of experts, interspersed with information and opinion feedback derived from earlier parts of a questionnaire program.***

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*Edwards, W. The Theory of Decision Making. Psychological Bulletin, 1954, 51(4), 380-417.

**Kneppreth, N. P., Gustafson, D. H., Leifer, R. P., and Johnson, E. M. Techniques for the Assessment of Worth. ARI Technical Paper 254, August 1974. (AD 784 629)

***Dalkey, N., and Helmer, O. An Experimental Application of the Delphi Method to the Use of Experts. Management Science, 1963, 9, 458-467.

In the present project, a three-round Delphi procedure was used to systematically solicit and collate informed judgments on factors influencing the selection of a worth assessment technique.

To keep the study within reasonable bounds, nine worth assessment techniques were selected for participant consideration. Each of the techniques has several variations and each represents a group of techniques with common attributes.

A brief description of each technique is given in Figure 1, while more complete descriptions are available in Kneppreth et al, 1974. In the present discussion, the role of worth assessor is differentiated from the role of decisionmaker (DM).

Although in many cases the worth assessor and the DM are the same person, the two roles represent different perspectives of a worth assessment problem.

The analysis of a worth assessment problem to select a technique for a given evaluation is the role of an assessor/analyst. The evaluation of the worth of a specific level of an attribute is the DM's role. Thus, from the assessor/analyst's viewpoint, the characteristics of the DM are factors in a worth assessment problem.

In the following sections, "factor" and "attribute" have slightly different meanings. Factor refers to a characteristic or peculiarity of the entire decision environment. Attribute is used in the more restrictive sense, referring to characteristics of variables being assessed - in this case, the assessment techniques. An attribute is a factor by this definition, but a factor is not necessarily an attribute.

THE DELPHI PROCEDURE

A three-round Delphi was used to obtain the informed judgments and opinions of 48 experts and practitioners in the field of worth assessment.

Round 1

The first Delphi questionnaire was sent to 48 people and was designed to determine what factors were important in choosing a worth assessment technique. The 48 persons in the sample were asked to respond to the following two questions:

> What factors would you consider important in deciding which worth assessment technique to use and why?
>
> What specific factors would likely affect the success of a worth assessment session? Give an example of what you mean.

Responses were received from 16 individuals who collectively listed 41 different factors (Figure 2). Anything considered important by a respondent was included as a factor.

Factors include characteristics of several widely different areas: the assessor, the problem, the decisionmaker, and the techniques. The diversity of opinion and the number of factors identified underscore the complexity of the worth assessment process.

Round 2

The second Delphi questionnaire, sent to the same 48 people who received Round 1, was designed to determine relative importance of the factors identified in Round 1. Individuals were provided a list of the 41 factors separated into five categories. They were asked to:

> Choose the nine most important factors from the entire list and indicate (in the space for comments) why you feel these are important, and how they affect selection.
>
> Rank order the nine factors, assigning a value of "1" to the most important and "9" to the least important.

Individuals were also asked to indicate the two or three most important factors within each of the five categories. Responses were received from 23 individuals, including 14 of the respondents to the first questionnaire.

The relative importance of each factor was determined by adding the inverse rankings that each factor received and then multiplying this sum by the number of respondents who indicated the factor was important. The relative weights normalized over all 41 factors on a 0 (least important) to 100 (most important) scale are shown in Figure 2.

The 4 factors in Figure 2 with a 0 relative weight were not considered critical by any respondent. The 37 critical factors can be useful in themselves to the practitioner as they elaborate what individuals in the field consider important when assessing worth. The knowledge that certain factors may adversely affect the outcome should help the practitioner anticipate and alleviate problems encountered in an assessment session.

The diversity of factors considered important indicates the need for further research in the area. Many of the factors identified are interdependent, and their empirical relationship to assessment success is unknown.

It would be useful to know the exact dependencies among factors and the exact relationships between the factors and assessment success. This information would increase not only the likelihood of successful worth assessment, but would enable the development of more precise selection and assessment strategies.

Round 3

The procedure was based on the assumption that there are attributes which differentiate various worth assessment techniques in the context of a particular decision situation. The 41 factors identified in Round 1 are not satisfactory in this regard.

While some of the factors do relate to attributes of assessment techniques, they do not differentiate between techniques. Many relate to more than one attribute, and several do not relate at all to attributes of the techniques.

Therefore, a set of attributes was inferred to account for the concerns expressed in the first two rounds of the Delphi and to differentiate among the techniques. By successively partitioning the 41 factors (Figure 2), six continuous and four dichotomous technique attributes appeared most appropriate (Figure 3).

These ten attributes appear to account for nearly all the factors listed in Figure 2, with the principal exception of several relating to the competence of the assessor. These ten technique attributes are the basis of the selection strategy developed later. While this set of attributes is not unique, it accounts for selection differences stated in the Delphi responses.

The four dichotomous attributes are easy to evaluate, as the level appropriate for each of the nine techniques (Figure 1) is fairly obvious. The continuous attributes are more difficult to evaluate and were the subject of Delphi Round 3.

The third Delphi questionnaire was designed to develop a profile of the six continuous attributes for each of the nine techniques. The questionnaire was sent to 17 individuals, chosen for their expertise and their familiarity with all nine techniques. Respondents were asked to rate each method on each of the continuous attributes. For instance, in the case of "Assessment Time" they were asked to:

> Please rate the following techniques on the relative time it takes to complete an assessment of a given attribute with a decisionmaker trained in using the technique. This is a measure of the face-to-face time an assessor and decisionmaker would spend in assessing a given attribute. It does not include training time of the decisionmaker. Please place a 10 next to the technique that you feel takes the least amount of time, and a 90 next to the technique which would take the most time. Rate the other techniques in relation to these two.

Responses were received from nine individuals and the resulting profiles are given in Figures 6 through 14.

A STRATEGY FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

The 10 decision situation attributes developed in the Delphi (Figure 3) form the basis of a strategy for selecting a worth assessment technique. The four dichotomous attributes, summarized in Table 1, represent characteristics of the decision attributes in the assessment problem.

The six continuous attributes summarized in the reference profiles (Figures 6-14) represent characteristics of the setting of the worth assessment problem.

The proposed selection strategy is designed to guide the user through an analysis of the decision problem in terms of these 10 attributes and to insure that these factors, which might determine the success of the application of worth assessment, are considered by the user (Figure 4).

There are three steps in the proposed strategy. The first step (Block 1 in Figure 4) is the analysis of the dichotomous attributes to screen out techniques not suitable for the situation.

As an example, if one of the attributes to be assessed in the decision is discrete and cannot be approximated as continuous, this difficulty will rule out several of the techniques: the graphic, constant probability, and indifference curve methods.

The four dichotomous attributes are analyzed using a series of questions for the assessor/analyst. After each question, one or more techniques may be ruled out from further consideration. In some cases only one feasible technique will remain at the end of this step, and the analyst need go no further.

In other cases, it will be apparent that more than one technique will be needed. For instance, one technique may be needed for dependent decision attributes, another for the remaining attributes.

If feasible to use more than one assessment technique, subsets of similar decision attributes should be handled separately in the remaining two steps of the selection strategy.

The second step (Block 2 of Figure 4) is to determine what values a technique should have for the six continuous attributes. The different factors in the situation that define the required levels of each of the continuous attributes are considered.

For instance, the time pressure of the study, the amount of time the decisionmaker has available, and the number of attributes involved will interact to define how quick the technique chosen must be. Each of the six attributes is a weighted composite of the situational factors developed in the Delphi that influence the value of the attribute.

This step yields a profile of the situation and defines a minimally acceptable technique. By comparing this situation profile with the profile of each of the techniques, it will be possible to reduce the subset of feasible techniques still further.

In the third step (Block 3 of Figure 4), the profile of the situation is compared with the normative reference profiles of each of the techniques remaining from the first step. Techniques which match or exceed the minimally acceptable profile on each attribute are considered feasible.

From these techniques, the one that best satisfies other criteria not yet considered in the analysis can be selected. An example of other criteria would be the amount of faith that the assessor/analyst has in the technique.

The main strength of the strategy is not that it insures a choice of the "perfect" technique. The chief strength is rather that it guides an analysis of the decision situation to force consideration of factors important in the choice of a technique.

All too often, the choice of an assessment technique is made on only one or two factors. Even then, the factors considered are not always the most critical. In addition, the strategy forces the assessor to consider all nine of the techniques rather than some restricted subset.

PROCEDURE FOR SELECTING A WORTH ASSESSMENT TECHNIQUE

Step 1

The four dichotomous attributes are listed below as a series of questions. If the answer to any one of them is "no," go on to the next questior; if the answer is "yes," continue with the explanations following the question.

Question 1. Are any of the decision attributes dependent?

If the value of an attribute depends on the level of another attribute, then the two attributes are said to be dependent. Stated another way, if the decisionmaker cannot specify values for an attribute without knowing the value of another attribute then dependencies are probably present.

The indifference curve method is the only method frequently used to handle dependent factors. This method could be the immediate choice for assessing dependent variables. However, the method has several shortcomings which often make it advantageous to modify the situation and use a different method. A series of procedures may make possible the use of another method.

Can the dependent attributes be combined into a single factor? Combining decision attributes may enable the composite attribute to be treated as independent. For instance, in a decision to purchase a car, fuel capacity (gallons) and fuel economy (miles/gallon) might be dependent attributes.

Combining them mathematically by multiplication gives a new attribute, fuel range (miles/tankful), that can be assessed as a single independent attribute. If possible to combine dependent attributes in the situation at hand, combine them and go to question 2.

Can the dependent attributes be assessed as pairs, triplets, or other combinations? If the set of all meaningful combinations of the dependent attributes is of reasonable length, then it may be advantageous to assess the attribute pairs as a single attribute.

If color and make of car are dependent and, for instance, blue is considered the best color for a Ford and green the best color for a Chevrolet, and three colors are being considered for each make of car, then the six color-make combinations may be assessed as a single attribute. If this combination is feasible in the situation, then go to question 2.

Can independence be assumed? Even if the attributes are dependent, it might be useful to assume they are independent. If the dependencies are such that independence is not an unreasonable assumption, e.g., the assumption will not affect the decision to any great degree, then simply assume they are independent and go to question 2.

If the decision attributes are dependent, and none of the above procedures is possible, then the indifference curve method must be employed. However, in practice this technique is limited to the assessment of two continuous monotonic attributes at a time. If more than two attributes are dependent pairwise, then some more sophisticated technique than the nine considered here has to be used.

For the situation with only pairwise dependent attributes, the indifference curve method must be used, and the analyst need go no further. However, if one or more interdependent pairs, plus one or more independent attributes are in the situation, continue to question 2.

Question 2. Does the decision situation involve risk?

Some analysts feel that a decisionmaker's subjective worth differs between risky and riskless situations. Thus, once a decision alternative is selected and the outcome is not known, some analysts prefer to use an assessment technique that includes some assessment of risk. If the situation involves risk, then the two gamble methods should be favorably considered and rejected only if they clearly do not meet the other criteria.

Question 3. Are any of the attributes nonmonotonically related to value?

An attribute is nonmonotonically related to value when an increase in the attribute over one part of the attribute's range increases the value to the decisionmaker, but an increase over another part of the attribute's range decreases the value to the decisionmaker. A nonmonotonic curve has one or more peaks or humps.

If any attribute is suspected of being nonmonotonically related to value, then it is advisable to limit the use of the gamble techniques and to eliminate the indifference curve method for consideration. The indifference curve method requires monotonicity, and problems in constructing wagers may arise with the gamble methods.

Question 4. **Are any of the decision attributes discrete?**

If any factors are discrete and cannot be approximated by a continuous function, then the graphic method, indifference curve method, and constant probability wagers should be rejected.

The dichotomous attributes of the nine assessment techniques are summarized in Table 1.

Step 2

At this point, the analyst should have an indication of how many different techniques might be required in the particular situation. For instance, it might be known that both the indifference curve method for the dependent attributes and one other technique to handle discrete factors would be necessary in the assessment process.

Each subset of attributes must be analyzed separately in steps 2 and 3. One technique, the indifference curve method, is known. The rest of the process would therefore be needed only to determine the best technique for the discrete attributes.

If there are time constraints, some of the subsets might be combined at this point to reduce the time needed for training decisionmakers in several different techniques. Training can take a great deal of time and place a heavy burden on the decisionmaker. If there is only one continuous attribute, it may be useful to assess it by the same method selected for the discrete attributes.

Based on the critical factors in a decision situation, questionnaires were developed (Round 3 of the Delphi) to evaluate the situational requirements for a worth assessment technique on the six continuous factors.

The Evaluation Questionnaires are shown in the appendix. The resulting values of these continuous factors obtained from the questionnaires form a profile of the minimally acceptable worth assessment technique which matches the decision situation. The same six evaluation questionnaires should be completed by the analyst in order to develop a meaningful comparison profile of the particular situation.

Table 1. Dichotomous Attributes of Assessment Techniques

Methods	Dependence	Risk	Nonmonotonicity	Discreteness
GAMBLE METHODS				
Constant Probability	?	YES	?	NO
Variable Probability	?	YES	?	YES
MULTIVARIATE METHOD				
Indifference Curve	YES	NO	NO	NO
ORDINAL METHODS				
Ranking	?	NO	YES	YES
Pair Comparisons	?	NO	YES	YES
Equivalence Grouping	?	NO	YES	YES
DIRECT METHODS				
Double Anchor	?	NO	YES	YES
Single Anchor	?	NO	YES	YES
Graphical	?	NO	YES	NO

Note. The entries represent answers to the questions: Will the technique handle dependent attributes; does the method involve risk; will the method handle attributes nonmonotonically related to worth; and, will the method handle discrete attributes.

To illustrate the profile of a minimally acceptable assessment technique, transfer the total scores developed from the questionnaires to the scales shown in Figure 5. Draw vertical lines at the points corresponding to the total scores, and shade the portion of the scale to the left of these marks. In this way, the situation profile can easily be compared with the graphic reference profiles of the nine assessment methods (Figures 6-14).

Step 3

Figures 6-14 give the reference profiles of the nine worth assessment techniques considered in the present development. The shaded portion on the left of each bar on the profiles extends to the mean value assessed during the Delphi, and constitutes the acceptable portion of the scale.

The crosshatched portion extends one standard deviation from the mean, and gives an indication of the relative agreement among the judges. In this step, the situation profile developed in Step 2 is compared to these profiles, and the most suitable technique is chosen. This step in the strategy is divided into three parts.

Part 1 of Step 3. The output of the comparison part of Step 3 will be a subset of techniques that matches or exceeds the situation profile on all factors. This subset is referred to as the feasible subset and may contain no techniques, or one or more techniques. If any techniques were rejected in Step 1, disregard these techniques throughout this step.

Compare the situation profile with the profiles in Figures 6 through 14. In each comparison, the technique should be rejected if it does not match or exceed the situation profile on all six factors. If the technique matches or exceeds the profile for all factors, the technique is considered part of the feasible subset. Only the shaded part of the profile is considered in the comparisons.

When this process is completed, the feasible subset may contain only one technique: This technique is the one considered most appropriate by the proposed strategy for the decision process under study, and the formal strategy ends here. However, the analyst should go back and check the selection against intuition. In some cases, there may be no techniques in the feasible subset, all the techniques having at least one factor which does not match or exceed the theoretical profile. In that case, further analysis is necessary. Omit part 2 and continue with part 3 of the step. If the feasible subset contains more than one technique, go to part 2.

Part 2 of Step 3. This part is for selecting from a group of feasible techniques. If the feasible subset contains several techniques, the final choice of technique must be made on the basis of additional criteria, since any one of the feasible techniques in the subset is probably appropriate for the situation. As an example of such criteria, the analyst might choose the technique that:

1. he has the most faith in and is most familiar with, or
2. will provide the DM with the best feedback, or
3. the DM has used before, or
4. allows for easy experimenting and value changing by the DM.

Possible criteria are numerous, and the choice can be made on any criteria that the assessor deems important. If no additional criteria are deemed important, and if a choice still cannot be made, part 3 of Step 3 can be followed to make a final selection.

Part 3 of Step 3. A method of choosing a technique on the basis of a weighted aggregate model is appropriate in situations in which either no feasible technique was found in part 1 of Step 3 or no choice among feasible techniques could be made.

First, the method attributes must be rated to determine their relative importance in the given decision situation. Figure 15 gives directions for developing attribute weights.

When weights have been determined for each of the attributes, one may determine a score for each technique by computing the weighted sum of the deviations of each reference profile from the situation profile.

For each technique being considered, determine the deviation from the situation profile, multiply each of these deviations by the appropriate attribute weight, and finally sum these across all the attributes of each technique.

A deviation is considered positive if the technique is rated higher than the situation profile. A deviation is considered negative if the technique is rated lower than the situation profile.

Table 2 shows an example of these calculations for one technique. The technique that has the highest score is chosen since this result indicates the least undesirable technique.

Table 2. Sample Calculations for Weighted Aggregate Approach

Method Attributes	Profile Ratings: Situation	Profile Ratings: Technique 'A"	Deviation	Weight	Product
Assessment Time	80	90	+10	10	100
Training Time	80	75	-5	3	-15
Flexibility	25	25	0	1	0
Face Validity	55	20	-35	2	70
Complexity	75	95	+20	9	180
Accuracy	70	75	+5	6	30
			SCORE FOR TECHNIQUE 'A'		+225

DISCUSSION AND SUMMARY

The strategy for selecting a worth assessment technique structures the analysis of an assessment problem in terms of ten composite attributes. The underlying assumption is that certain factors of the total assessment problem are critical to success of the worth assessment process.

The 10 attributes of the strategy represent a synthesis of 41 factors identified in the Delphi procedure (Figure 2). The success of the strategy depends on the extent to which the critical factors were captured in the Delphi and incorporated into the analysis.

A relatively small number of those queried responded to the Delphi questionnaire. However, even the small sample of respondents in round 3 (9) represented many years of experience in worth assessment by active practitioners in the field.

The nine techniques included in the analysis (Figure 1) represent the most frequently used assessment techniques. Each of the techniques actually represents a family of techniques with similar characteristics (Kneppreth et al, 1974, op. cit.). Considering additional techniques would not require a change in the strategy, but would require extending the procedure to develop further reference profiles.

The 10 attributes of the techniques represent two types of factors in an assessment problem. The first type, the four dichotomous attributes summarized in Table 1, focuses on the characteristics of the decision attributes in the assessment problem.

The analysis of the dichotomous attributes is in terms of the limitations inherent in the application of a worth assessment technique in any situation: Is the technique feasible for a specific problem?

The second type, the six continuous attributes, focuses on the setting of the worth assessment problem. The analysis of the continuous attributes is in terms of the constraints governing the application of any worth assessment technique in a situation: Is the technique acceptable for a specific situation?

The 10 attributes do not represent an exhaustive synthesis of factors determining the successful application of a worth assessment technique. The goal was not completeness, but rather inclusion of the critical factors.

This strategy represents an initial attempt to structure the problem of selection of a worth assessment technique. The strategy is designed to guide the user through an analysis of the assessment problem in terms of factors critical in the successful application of worth assessment.

The relative contribution of the different factors to assessment success, as well as the scales used for depicting situations in terms of these factors, represents the authors' analysis and insights derived from the Delphi process and a review of worth assessment techniques rather than being empirically derived.

Further definition of the relationships noted in the analysis, validation, and refinement of the strategy is required. A strategy that focuses analysis of the assessment problem on factors accepted by experts as being important in applying worth assessment techniques should increase the likelihood of successful decisionmaking.

GAMBLE METHODS

CONSTANT PROBABILITY WAGERS involve constructing wagers (usually with probabilities of 1/2) and then varying the factor levels until the dm is indifferent between the wager and an alternative 'sure thing'. Yields interval data.

VARIABLE PROBABILITY WAGERS involve constructing wagers and then varying the probabilities until the dm is indifferent between the wager and an alternative 'sure thing'. Yields interval data.

MULTIVARIATE METHODS

INDIFFERENCE CURVE METHOD involves the joint assessment of two attributes by constructing a plane of the possible combinations and then determining indifference points and curves. Can be used to assess two dependent or two independent attributes at a time. Yields ordinal data.

ORDINAL METHODS

RANKING involves placing rank numbers on a form or sorting cards into an order. Yields ordinal data.

PAIRED COMPARISONS involve choosing the preferred attribute levels in each of a series of pairs. Yields ordinal data.

EQUIVALENCE GROUPING involves placing factor levels into a discrete number of classes representing varying degrees of worth. It may involve forms or sorting cards into piles. Yields partial rank order with some interval information.

DIRECT METHODS

SCALED RESPONSE (DOUBLE ANCHOR) involves identifying the two extremes of the attribute scale and then anchoring the extremes. Intermediate attribute levels are then assessed by giving numbers or drawing marks on a scale. Yields interval data.

SCALED RESPONSE (SINGLE ANCHOR) involves anchoring one attribute level to a scale and then rating the other levels in relation to this point (usually by ratios). May involve eliciting numbers or marking a scale. Yields interval data.

GRAPHICAL METHOD involves drawing directly onto a graph, with one axis for worth and the other for the attribute levels, a line which represents the worth function of the attribute. Some points are usually anchored. Yields interval data.

Figure 1. Brief Descriptions of Nine Worth Assessment Techniques

Relative Weight	Factor
Decision Problem/Situation and Purpose	
100	The required sensitivity of the results
92	The decision model
56	The size of the decision problem
48	Whether the problem involves risk or not
41	Whether the worths are invariant over time
22	Whether the situation is static or dynamic
18	Whether the purpose is normative or descriptive
16	The degree of accuracy desired in the results
14	The number of decisionmakers to be assessed
4	Whether past choice data is available
2	Whether one is modelling choices or processes
1	Whether alternatives can be compared to a standard
0	Probability of a unique final choice
0	The order of processing the attributes
0	The location of the worth assessment session
Assessor/Analyst	
95	The expertise of the assessor
39	The amount of faith that the assessor/analyst has in the technique
14	The assessor's familiarity with the technique
6	Previous relationship between the assessor and decisionmaker (DM)
4	Motivation of the assessor
Decision Attributes	
100	The number of decision attributes
93	Whether or not the decision attributes are independent
15	Whether attributes are nonmonotonically related to worth
14	Whether attributes are continuous or discrete and have definite end points
7	Whether attributes can be resolved into a single dimension
2	Whether some combinations of attribute levels are not possible
Decisionmaker(s)	
75	The ease with which the DM can understand the technique
70	The importance of the decision to the decisionmaker
45	The information demanded from the decisionmaker
28	The value of time expended by the decisionmaker
23	Whether the DM will benefit from giving his/her worths
1	The sophistication and vocabulary of the DM
1	(For Group Decisions) Whether the DM will feel that his/her expertise will be recognized
0	(For Group Decisions) Personality, attitude, and status of the DM
Techniques	
56	Known biases of the technique
45	The cost of administering the technique
29	The face validity of the technique
21	The amount of education required to use the technique
21	Whether or not the technique allows feedback
10	Whether the results of the technique can be cross-checked
6	Whether the technique allows immediate value changing or experimenting

Figure 2. The Relative Weights of Critical Factors in Worth Assessment

Dichotomous Attributes

Independence: A decision attribute is independent if its value does not depend on knowing the level of another attribute.

Risk: A decision problem involves risk if the decision is related to probabilistic outcomes.

Monotonicity: A decision attribute is monotonically related to value if an increase (or decrease) in the attribute increases (or decreases) the value to the DM over its entire range.

Discreteness: A decision attribute is discrete if only a limited number of levels exist.

Continuous Attributes

Assessment Time: The relative amount of time required to complete an assessment of a given attribute with a DM trained in using the technique.

Training Time: The relative amount of time required to train a DM, with no previous knowledge of the technique, in the use of the technique.

Face Validity: The relative appearance to the DM that his/her responses yield useful and meaningful information.

Accuracy: The relative precision with which the technique elicits a DM's true worth perspective as well as the technique's sensitivity to variations in the DM's worth function.

Flexibility: The relative ease with which the technique can be modified to suit different situations and DMs, and the ease with which a DM can modify his/her worth function.

Complexity: The relative complexity of the DM's task in using the technique; including the abstractness of required responses and the number and order of different activities.

Figure 3. Attributes Used in the Selection Strategy

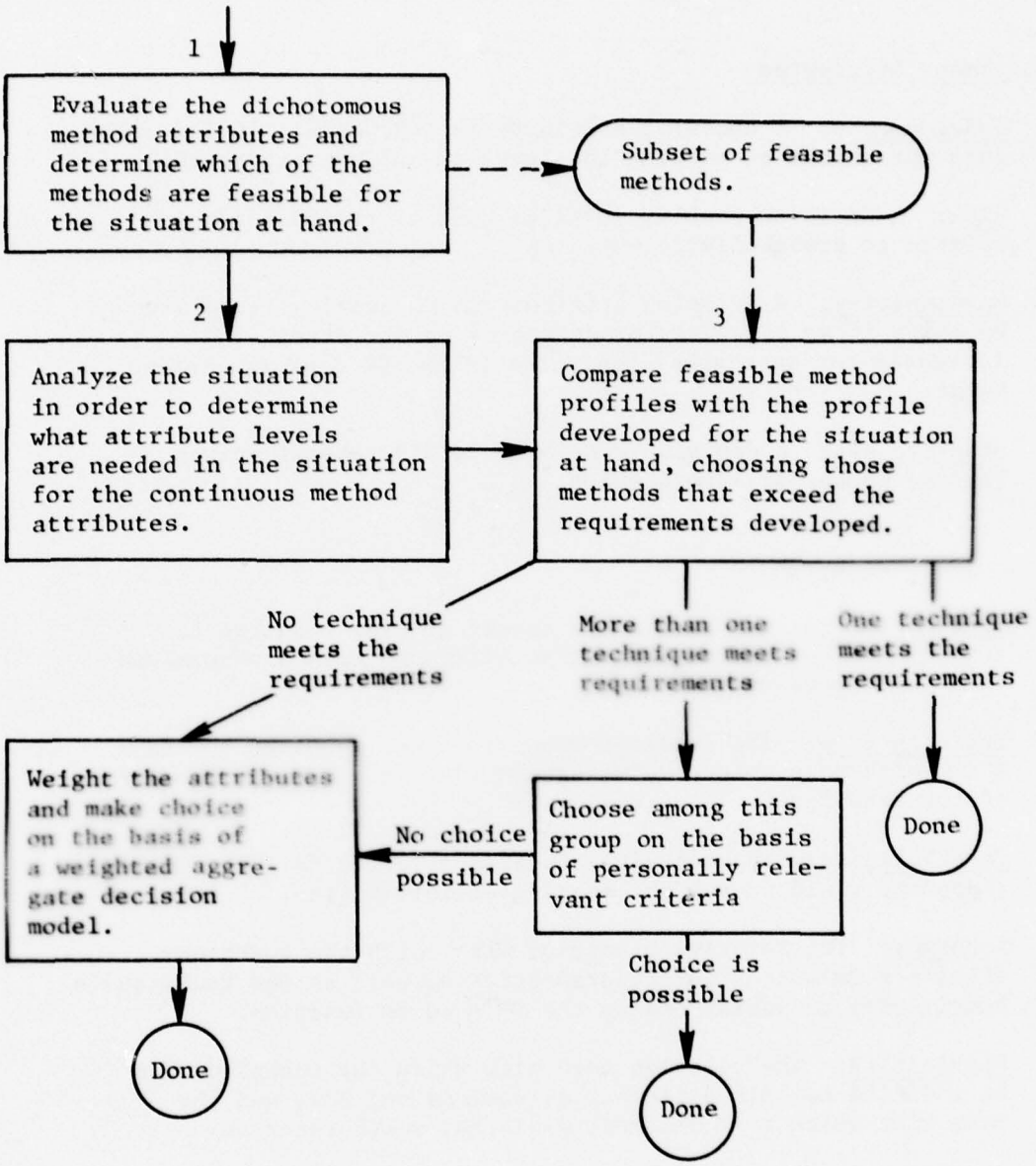

Figure 4. Flow Chart Summarizing the Strategy for Selecting a Worth Assessment Technique

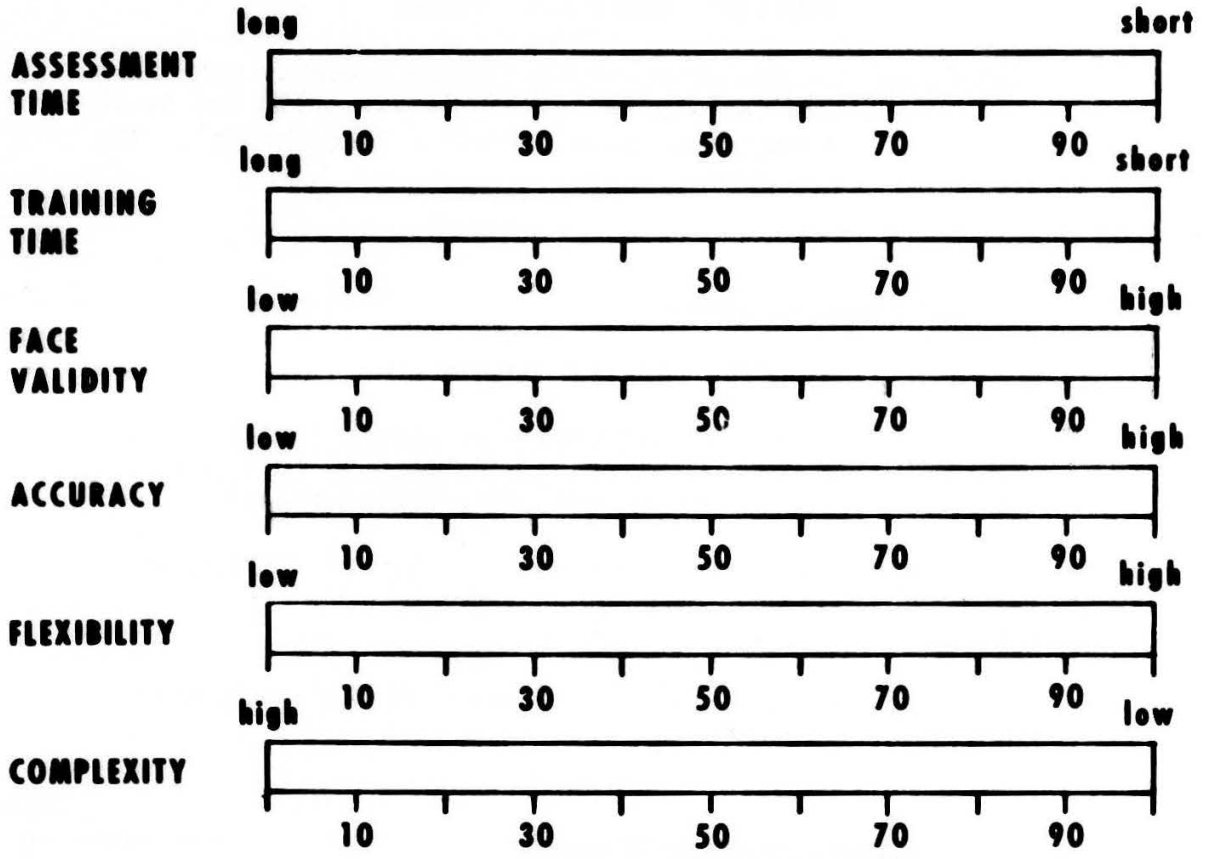

Figure 5. Blank Situation Profile

CONSTANT PROBABILITY WAGERS

These techniques involve constructing wagers (usually with probabilities of 1/2) and then varying the factor levels until the dm is indifferent between the wager and an alternative 'sure thing'. The technique yields interval data.

DICHOTOMOUS FACTORS:

Risk? The technique involves risk and probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? While the technique can theoretically handle nonmonotonically related attributes, there may be problems in varying the factor levels and constructing wagers.

Discrete? The technique will not handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

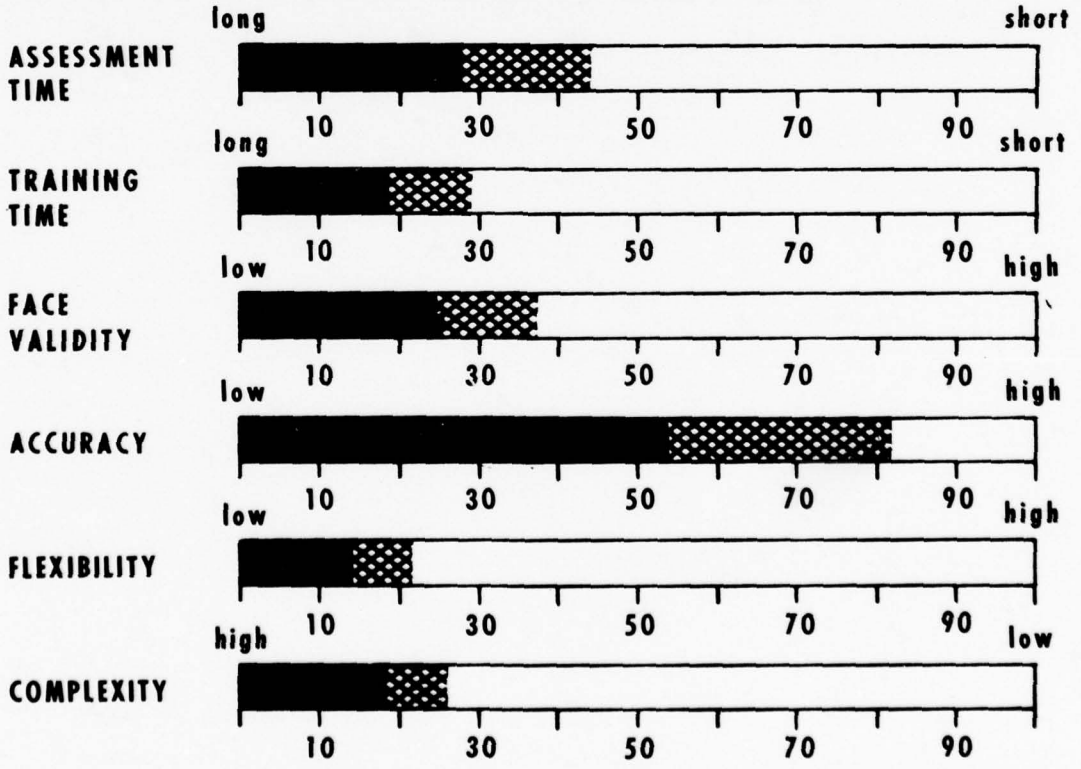

Figure 6. Reference Profile of Constant Probability Wagers

VARIABLE PROBABILITY WAGERS

This technique involves constructing wagers and then varying the probabilities until the dm is indifferent between the wager and an alternative 'sure thing'. The technique yields interval data.

DICHOTOMOUS FACTORS:

Risk? The technique involves risk and probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique can theoretically handle attributes that are nonmonotonically related to worth. However, problems may arise in constructing the wagers.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

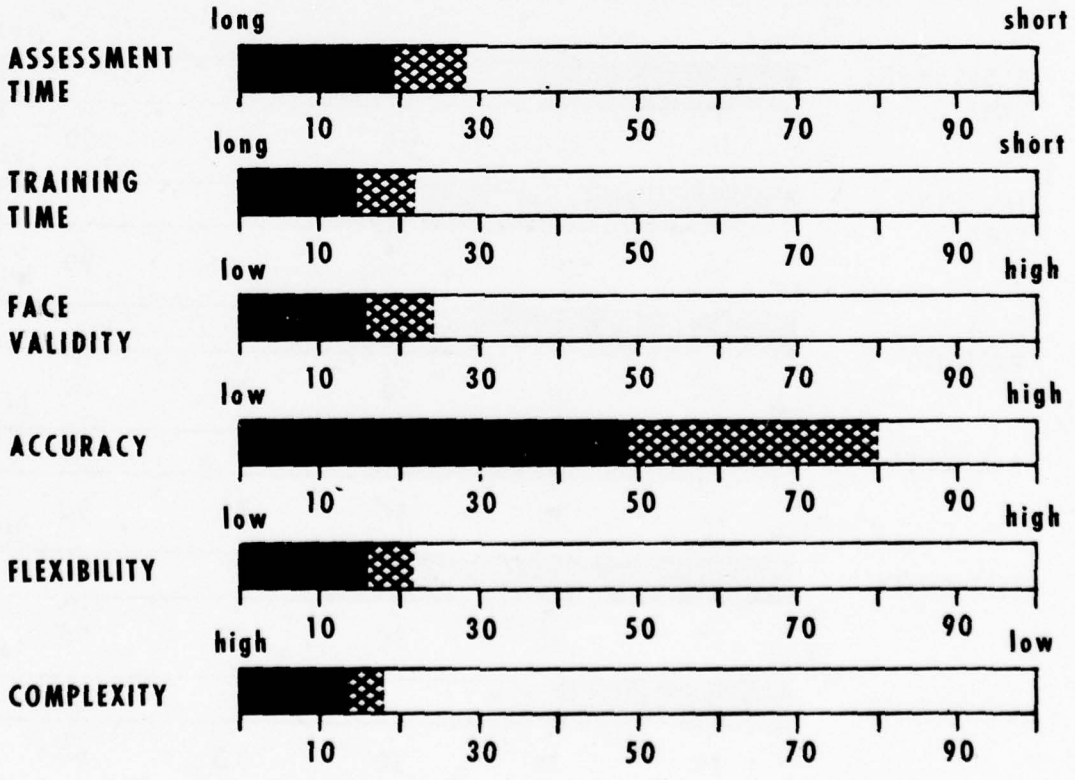

Figure 7. Reference Profile of Variable Probability Wagers

INDIFFERENCE CURVE METHOD

This method involves the joint assessment of two attributes, and is accomplished by constructing a plane of the possible combinations of the two attributes and then determining indifference points and curves on this plane. The technique yields ordinal data.

DICHOTOMOUS FACTORS:

Risk? This technique does not involve risk or probabilities.

Dependence? This technique handles dependencies however, it is realistically limited to assessment of only two dependent attributes.

Nonmonotonicity? This technique cannot assess attributes which are nonmonotonically related to worth.

Discrete? This technique is inappropriate for discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

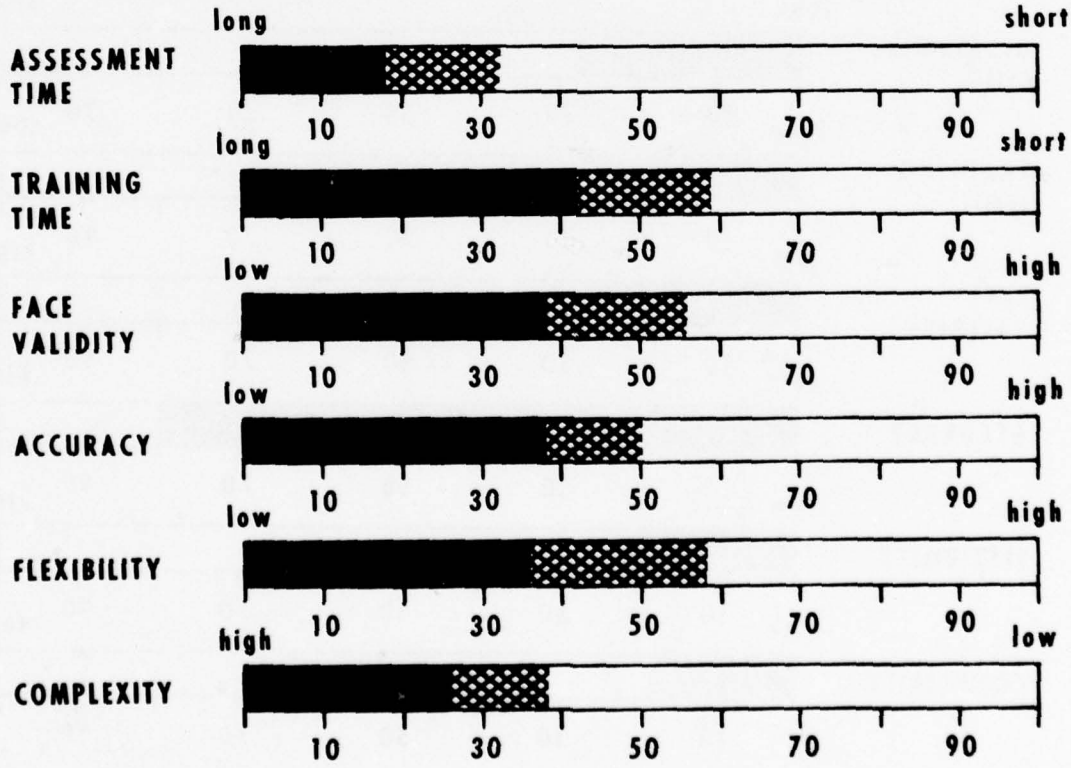

Figure 8. Reference Profile of the Indifference Curve Method

RANKING METHODS

These techniques involve placing rank numbers on a form or sorting cards into rank order. The technique yields ordinal data.

DICHOTOMOUS FACTORS:

Risk? These techniques do not involve risk or probabilities.

Dependence? *The technique will not handle dependent attributes.*

Nonmonotonicity? The techniques can assess attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

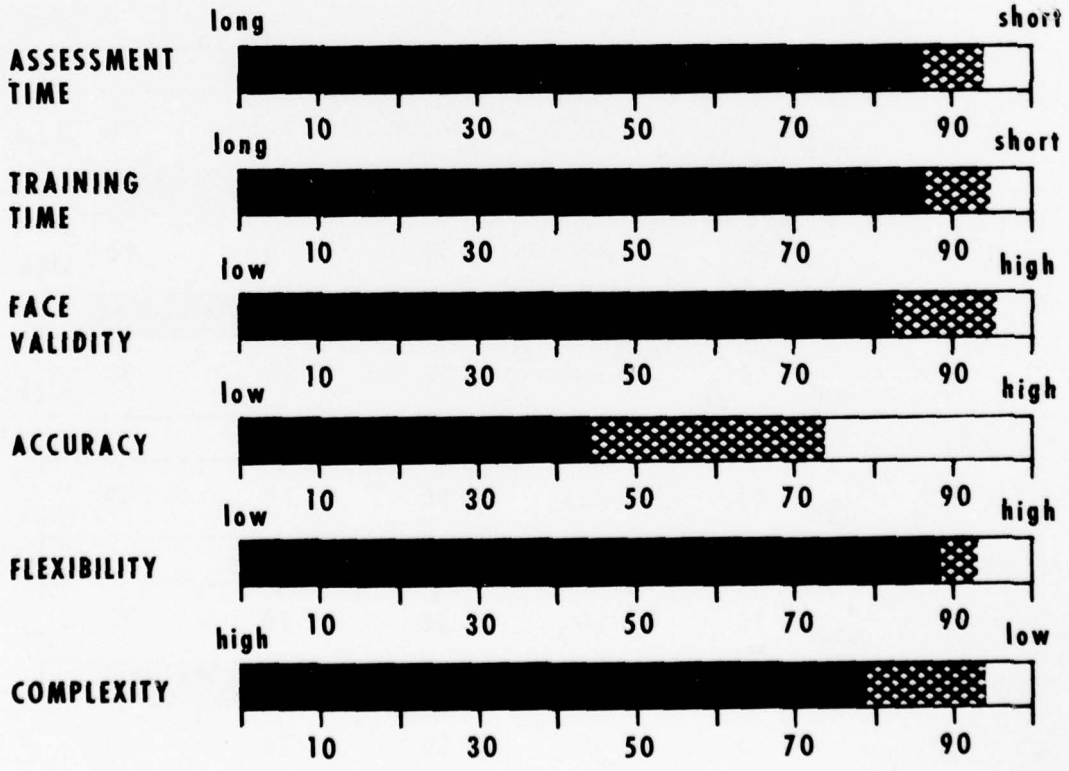

Figure 9. Reference Profile of Ranking Methods

PAIRED COMPARISONS

This technique involves choosing the preferred attribute levels in each of a series of pairs. The technique yields ordinal data.

DICHOTOMOUS FACTORS:

Risk? The technique does not involve risk or probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique can assess attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

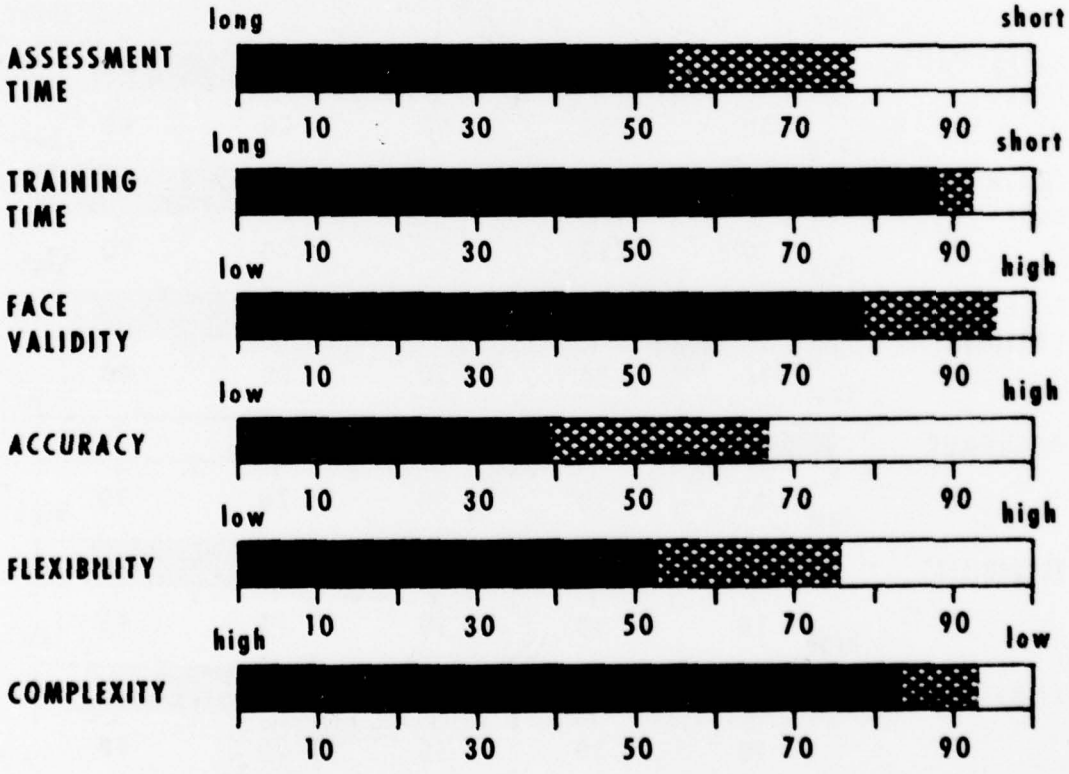

Figure 10. Reference Profile of Method of Paired Comparisons

EQUIVALENCE GROUPING

These techniques involve placing factor levels into a discrete number of classes representing varying degrees of worth. They may involve forms or sorting cards into piles. The technique yields partial rank order with some interval information.

DICHOTOMOUS FACTORS:

Risk? The technique does not involve risk or probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique can handle attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

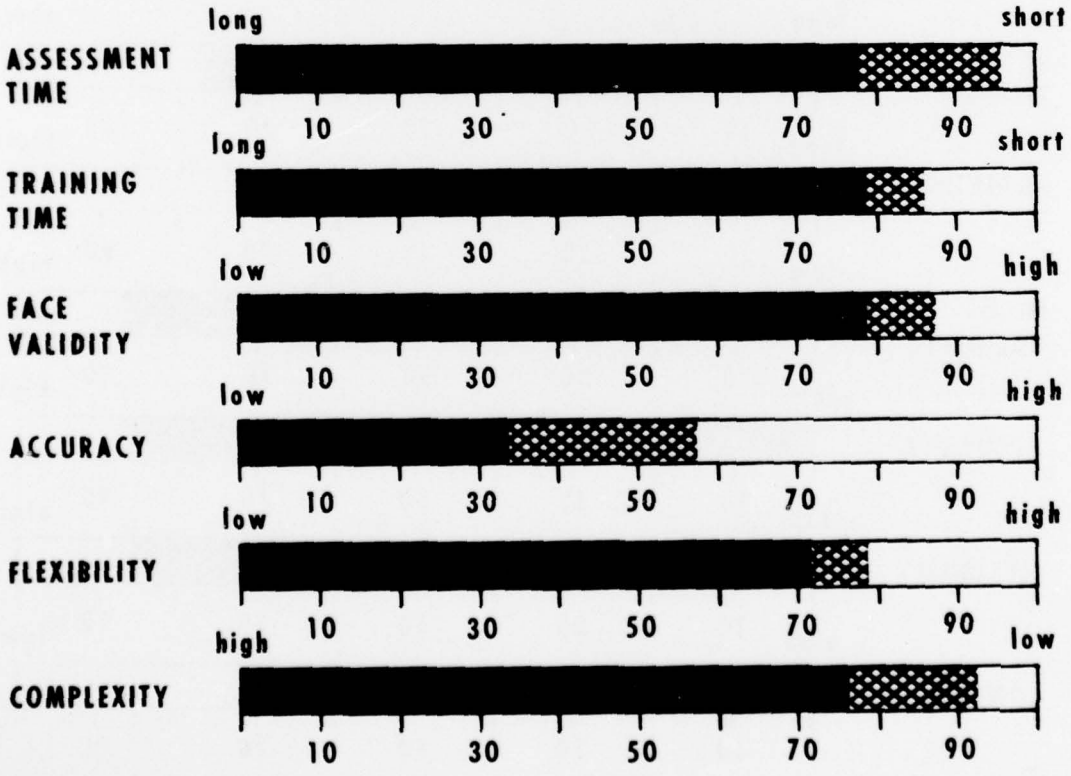

Figure 11. Reference Profile of Equivalence Grouping

SCALED RESPONSE (DOUBLE ANCHOR) METHOD

The technique involves anchoring the extremes of the worth scale to the extreme attribute levels and then assessing intermediate levels in relation to these two points either by giving numbers or drawing marks on a scale. The technique yields interval data.

DICHOTOMOUS FACTORS:

Risk? The technique does not involve risk or probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique will handle attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

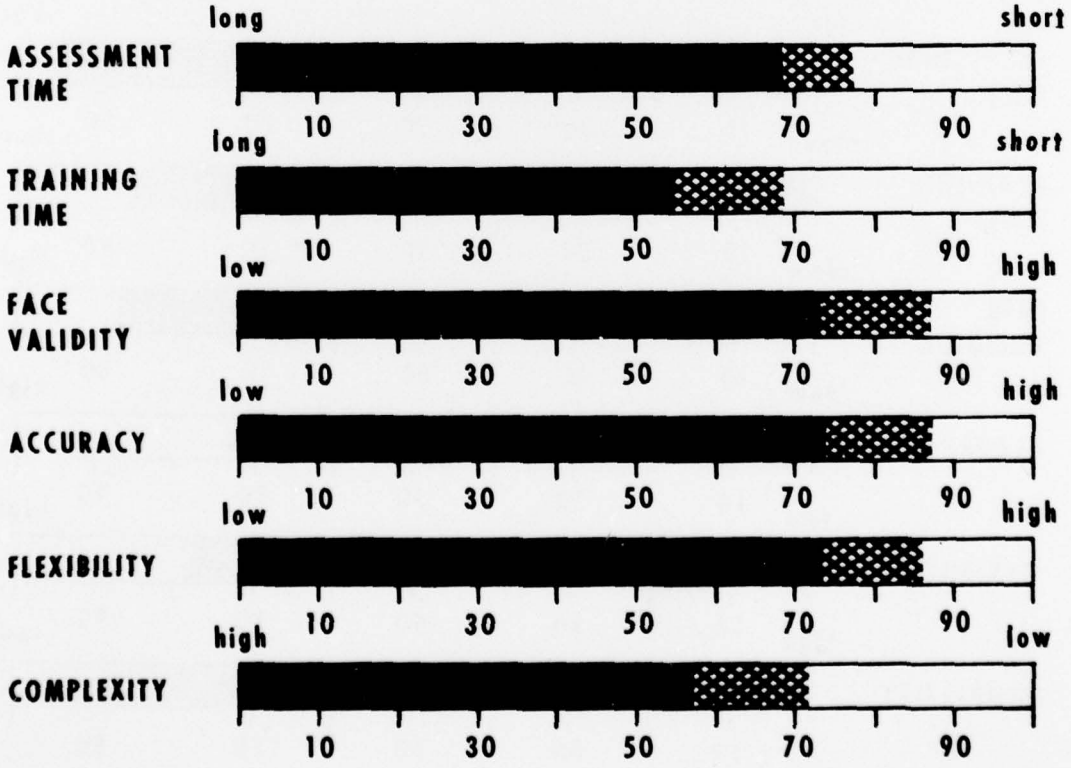

Figure 12. Reference Profile of Scaled Response (Double Anchor) Method

SCALED RESPONSE (SINGLE ANCHOR)

This technique involves anchoring one attribute level to a scale and then rating the other levels in relation to this point (usually by ratios). May involve eliciting numbers or marking on a scale. The technique yields interval data.

DICHOTOMOUS FACTORS:

Risk? The technique does not involve risk or probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique will handle attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

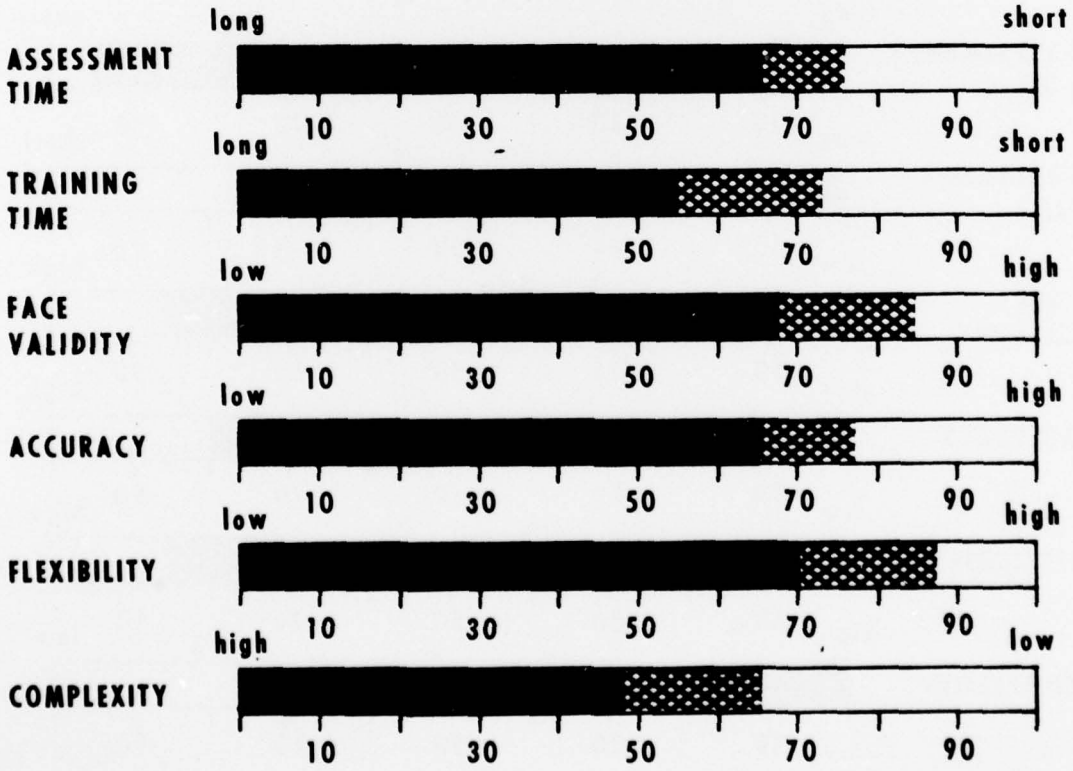

Figure 13. Reference Profile of Scaled Response (Single Anchor)

GRAPHIC METHOD

This technique involves drawing directly onto a graph, with one axis for worth and the other for the attribute levels, a line which represents the worth function of the attribute. Some points are usually anchored. The technique yields interval data.

DICHOTOMOUS FACTORS:

Risk? The technique does not involve risk or probabilities.

Dependence? The technique will not handle dependent attributes.

Nonmonotonicity? The technique will handle attributes which are nonmonotonically related to worth.

Discrete? The technique will handle discrete attributes.

CONTINUOUS FACTORS:

The crosshatched portion extends one standard deviation from the mean (shaded portion).

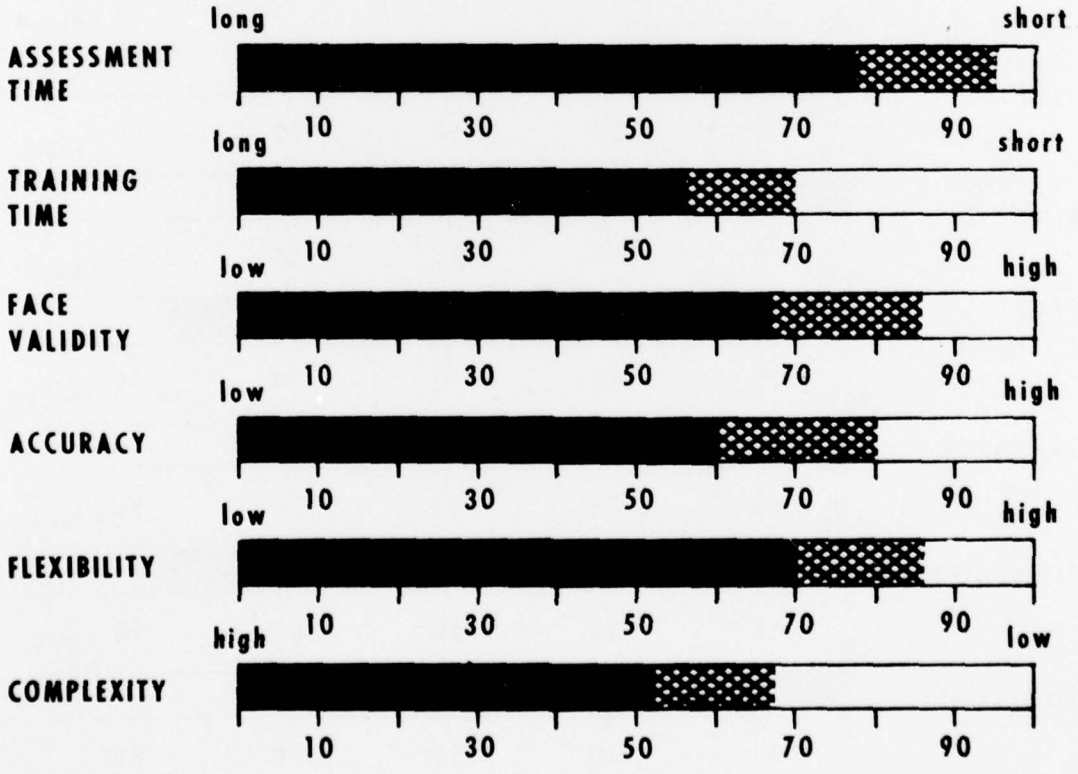

Figure 14. Reference Profile of Graphic Method

Read the list of attributes below and choose the one that you feel is least important in your decision situation. Assign a score of 1 to this attribute. Now choose the one which seems to be most important and assign a 10 to it. These two numbers form the endpoints of a scale of importance. Please rate the other four attributes in relation to the two already specified. These numbers become the weights for the attributes for part 3 of the strategy.

SCORE	ATTRIBUTE
_____	Assessment Time - the amount of time available for assessment sessions.
_____	Training Time - amount of time available for training the dm.
_____	Face Validity - the amount of faith the dm must have in the method.
_____	Accuracy of Results - the required specificity of the results.
_____	Flexibility - the number of variations required.
_____	Complexity - difficulty of the dm's task.

Figure 15. Instructions for Weighting the Method Attributes

APPENDIX A

EVALUATION QUESTIONNAIRES FOR ASSESSING SITUATIONAL REQUIREMENTS FOR ASSESSMENT TIME, TRAINING TIME, FACE VALIDITY, ACCURACY, FLEXIBILITY, AND COMPLEXITY

ASSESSMENT TIME

Score

Time Pressure: Rate on a zero to 20 scale the relative time horizon of the decision process. Rate as zero a situation in which there is no time pressure to make a decision. Rate as 20 a situation in which the decision must be made as quickly as possible . . . . . _____

Decisionmaker (DM) Time Available: Rate on a zero to 30 scale the amount of DM time available. Rate as zero when there is an unlimited amount of DM time. Rate as 30 when there is little time available. Time available will depend not only on the physical constraints of the DM but also on the DM's motivation. If the DM is unmotivated, he/she may not be willing to give much time to the assessment . . . . _____

Number of Decisionmakers: Rate on a zero to 20 scale the number of DMs to be used in the assessment process. Rate as zero when there is only one DM. Rate as 20 when there are five or more DMs. If more than one DM are going to be treated as a group and there will be one assessment session for the group, rate this as a 5 . . . . . _____

Number of Attributes: Rate on a zero to 30 scale the number of attributes to be assessed. Rate as zero when there is only one attribute to be assessed. Rate as 30 when there are 10 or more attributes to be assessed . . . . . _____

TOTAL SCORE (sum of the above) _____

Other Considerations: The total score can be modified slightly depending on several considerations. For instance, if a decisionmaker is not sophisticated and likely to be slow with worth assessment, then increase the total score. Or, if there is little money to pay the DMs for their time (if this is the case), then the total score also should be increased. If any other characteristics of the situation tend to make time critical, increase the total score and if any characteristic makes time less critical, decrease the total score.

TRAINING TIME

Score

Time Pressure: Rate on a zero to 20 scale the relative time horizon of the decision process. Rate as zero a situation in which there is no time pressure. Rate as 20 a situation in which the decision must be made as quickly as possible . . . . . _____

Decisionmaker Time Available: Rate on a zero to 20 scale the amount of time that the DMs have available. Rate as zero a situation where the DMs have an unlimited amount of time to spend. Rate as 20 a situation where the DMs have very little time available. If the DMs are very unmotivated, training may take more time and the value here should be increased . . . . . _____

Number of Decisionmakers: Rate on a zero to 30 scale the relative number of decisionmakers. Rate as zero a situation where only one DM need be trained. Rate as 30 where five or more DMs are to be trained. If the DMs are to be trained as a group then rate this factor a 10. . . . . _____

Number of Methods: Rate on a zero to 30 scale the relative number of methods that will be employed in the assessment process. This is a measure of the number of techniques to be employed for the different types of attributes. Rate as zero a situation where only one technique will be used. Rate as 30 a situation where four or more techniques will be used . . . . . _____

TOTAL SCORE (sum of the above) _____

Other Considerations: The total score can be modified based on several other considerations. If the DM is not familiar at all with worth assessment or if he/she is not sophisticated in these types of techniques, training may take longer and the value of the total score should be increased. If there are factors which, in your situation, will decrease the time for training, decrease the total score appropriately.

FACE VALIDITY

Score

Past Contact Between DM and Assessor: Rate on a zero to 50 scale the relative degree of faith that the DM has in the assessor. It will depend on past contacts with the DM, and the reputation of the assessor as <u>perceived</u> by the DM. Rate as zero a situation in which the DM has complete faith in the assessor. Rate as 50 a situation in which the DM distrusts the assessor. Rate as 20 if the DM and the assessor have not met . . . . . _____

Importance of the Decision to the DM: Rate on a zero to 30 scale the relative importance of the decision to the DM. Rate as zero a situation in which the DM does not consider the decision important. Rate as 30 a situation in which the DM feels that the decision is very important and wants to ensure that his/her value is assessed validly . . . . . _____

Status of the DM: Rate on a zero to 20 scale the relative status of the DM. Rate as zero a situation in which the DM is of low status and has been "ordered" to take part in the assessment. Rate as 20 a situation in which a high status person who is taking part in the assessment of his/her own free will . . . . . _____

TOTAL SCORE (sum of the above) _____

Other Considerations: The education and sophistication of the DM might affect this factor. A highly sophisticated DM may require the technique to have a higher face validity (or possibly a lower face validity). In any case if it is felt that a higher face validity is needed for one reason or another, the total score may be increased.

ACCURACY

Score

Cost of Making an Incorrect Decision: Rate on a zero to 30 scale the relative importance of the decision. Rate as zero a situation in which the decision is not important and no adverse effects would occur from making an incorrect decision. Rate as 30 a situation in which the decision is extremely critical and the cost of making an incorrect decision is very high . . . . . _____

The Model: Rate on a zero to 20 scale the type of measurements required by the decision model to be used. Rate as zero a model which requires anything less than full rank order, and rate as 20 a model which requires strict interval data . . . . . _____

Number of DMs: Rate on a zero to 30 scale the number of DMs to be used in the assessment process. If there are many decisionmakers whose worth functions will somehow be averaged, then the individual assessments will be less critical. Rate as zero a situation in which there are many DMs over which worths would be averaged. Rate as 30 a situation in which there is only one DM . . . . . _____

Number of Attributes: Rate on a zero to 20 scale the number of activities to be assessed. As the decision is based on more attributes, the effects of any single one will be reduced. Rate as zero a situation in which there are very many attributes. Rate as 20 a situation where there are few attributes . . . . . _____

TOTAL SCORE (sum of the above) _____

Other Considerations: There are many other considerations which will affect the required sensitivity of the worth assessment technique. For instance, if the purpose of the assessment is to determine how values change over time, it may be important to use a more sensitive method. If the situation requires a more accurate method, increase the total score.

FLEXIBILITY

Score

The Number of Different Variations: Rate on a zero to 40 scale, the number of different variations of assessment techniques that will be required for different decision attributes. This is an indication of the number of different types of attributes that the method will encounter. Rate as zero a situation where the technique will not have to be modified to suit different attributes . . . . . _____

The Number of Different DMs: Rate on a zero to 60 scale the number of variations of the selected method that will be required to suit different decisionmakers. Rate as zero a situation in which no variations will be necessary. Rate as 60 a situation where there are five or more different DMs who will require variations . . . . . _____

TOTAL SCORE (sum of the above) _____

Other Considerations: In general this will not be an important consideration in the selection of a worth assessment technique. However, in some situations it is important to tailor the technique to meet various conditions. In this type of situation the total score should be increased.

COMPLEXITY

Score

Sophistication of the DM: Rate on a zero to 50 scale the educational level and quantitative abilities of the DM. Rate as zero a situation in which the DM is highly educated and unlikely to have trouble with any of the worth assessment techniques. Rate as 50 a situation in which the education level is low and there is a good possibility that the DM will have much trouble . . . . . _____

Motivation of the DM: Rate on a zero to 50 scale the relative level of motivation of the DM. Rate as zero a situation in which the DM feels the decision is important and is highly motivated. Rate as 50 a situation in which the DM does not feel the decision is important and is not motivated to cooperate with the assessment. . . . . _____

TOTAL SCORE (sum of the above) . . . _____

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1 USA Air Def Sch, Ft Bliss, ATTN: ATSA-CTD-ME
1 USA Air Def Sch, Ft Bliss, ATTN: Tech Lib
1 USA Air Def Bd, Ft Bliss, ATTN: FILES
1 USA Air Def Bd, Ft Bliss, ATTN: STEBD-PO
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